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UNIVERSITY OF CALIFORNIA
SAN FRANCISCO MEDICAL CENTER

July 20, 1964

Ralph E. Knutti, M.D. Director
National Heart Institute
Bethesda, Maryland 20014

Dear Ralph:

Thank you for your letter and the enclosures. Since the last meeting of the National Advisory Heart Council I have talked to several cardiac surgeons and scientists working on cardiovascular problems, and was about to put in writing for you some of my views on the development of scientific equipment and of substitutes for organs and tissues, such as the artificial lung, plastic heart valves, artificial heart and artificial kidney.

I have believed for many years that biological scientists should have far greater engineering resources available to them for developmental work. In general it seems to be true that more of the top-notch physiologists, biochemists, pharmacologists, geneticists and immunologists work in universities or pure research institutions than in industrial laboratories. On the other hand, I believe it is also true that more of our top-notch chemical, electrical and mechanical engineers* work in industrial laboratories than in universities. Certainly no one medical school or university has available a wide spectrum of highly talented chemical, electrical and mechanical engineers for full-time or consultative participation in biological research or for the development of novel equipment or replacements for important organs or tissues. In my opinion the work on the artificial heart and lung begun 30 years ago by Dr. John Gibbon in Philadelphia could have been brought to completion 15-20 years earlier if the development of the apparatus had been given to the best and most diversified talent in industry once Dr. Gibbon had conceived the idea and outlined the general specifications. I believe that the same is true of cardiac valves, the artificial kidney, and now the artificial heart. I realize that some members of departments of surgery in some medical schools in this country are clever with their hands and have inventive ability and talent for working in the shop in addition to working in the operating room nevertheless I believe that development, which often follows biological research, would be accelerated if government provided the financial support to give the developmental problems to industry.

Let me give you a simple example:- during the second World War when physiologists at the University of Southern California were working

* Some of these are consultants

on positive pressure breathing and its usefulness in aviation medicine, they wanted to determine the physiological effects of positive pressure breathing applied only during inspiration; to do this they breathed through a large 3-way stopcock, turned the tap to a source of compressed air during inspiration, turned it back again by hand to atmospheric pressure during expiration, and so on cycle after cycle, minute after minute, and hour after hour. A mechanical engineer, Mr. Floyd Bennett, happened to be visiting the laboratory that day and remarked that the same procedure could be done very easily mechanically. Within a short period of time he produced the Bennett valve, the forerunner of many of the valves used today for positive pressure breathing and for controlled breathing during anesthesia. This ingenious mechanical engineer, whose salary was far too high to be paid by a medical school budget, solved a problem simply because he (and his trained mind) happened to be there during this experiment. When your predecessor, Dr. James Watt, visited us a few years ago, encouraging us to apply for a Program Project Grant, he asked us specifically to include in the budget salaries for an electrical and a mechanical engineer who would "live with" our biological scientific group in the hope that close collaboration would solve similar problems. However, this is really not enough and in my opinion, the collaboration must be of a different order of magnitude.

On October 4-6, 1959, the Biophysics Study Section of the NIH had a Conference on "Biophysical and Biomedical Instrumentation" at Princeton, New Jersey, under the co-chairmanship of Dr. Frank Fremont-Smith of the Macy Foundation and Dr. Urner Liddel of the NIAMD. I was one of the small group who attended the meeting. Some of the participants were leaders in industry. I do not have the final report available to me at the present time, but the general conclusions were that it would be highly advantageous to medical science if government could somehow support developmental research on a large scale, long-term basis, possibly in regional centers where the specially talented engineers could be available to a number of universities and research institutes rather than only to one. The representatives of industry indicated that they would be very happy to cooperate if they were assured long-term support. I am not sure what happened to the recommendations of this conference; Dr. Liddel might be able to supply the information.

In any such problem as development of artificial valves or of a mechanical heart there are both biological and engineering problems. The biological problems are fairly well known. They include the problem of infection (if there is to be any permanent connection between the thoracic cavity and the outside), the problem of transmission of energy (if there is to be an implanted heart), the effect

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of the mechanical heart on the formed elements of the blood, the reaction of the body to the foreign material, and the question of biologic regulation (the latter is probably not of primary importance because the various tissues of the body seem to be able to draw on the reserve oxygen and other materials in arterial blood without the necessity for increasing cardiac output, up to metabolic rates about double resting values). If there is general agreement that the biologic problems can either be solved or circumvented and that a mechanical heart is possible, then I would hope that the engineering aspects of the problem could be worked on simultaneously by industry with close cooperation with the best consultants in each of the pertinent biological fields. My recommendation is not that research on the mechanical heart should be taken out of the hands of the surgeons or other biological scientists and given to industry, but that surgeons and other biological scientists should work with industry and advance both aspects simultaneously.

I shall be very happy to talk to you more about this in person. I will be in Washington on September 25 (meeting at the National Academy of Science) and, of course, in Bethesda at the November Heart Council meeting. I will be in San Francisco continuously until September 23 and would be available to talk with you if you happen to be in this area.

Sincerely,

JULIUS H. COMROE, JR., M.D.
Director

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cc: Dr. J. Lederberg ✓